the second oöcyte would be expected to be very small relative to the number of cases involving inversions. A large percentage of the former would be eliminated by the meiotic process, due to the formation of aneuploid gametes. Since Metz and Boche found an equal number of translocations and inversions after treatment of sperm, where the chromosomes had already passed through the maturation process, it would seem probable that an approximately equal number of translocations and inversions would occur (but not be recovered) in the present case. The fact that only one translocation was recovered, in contrast to 13 inversions, seems to indicate that, in this case, all the rearrangements occurred before the end of the first meiotic division.

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THE INFRA-RED SPECTRA OF SiH_4 AND GeH_4

BY CHARLES H. TINDAL, JOSEPH W. STRALEY AND HARALD H. NIELSEN

MENDENHALL LABORATORY OF PHYSICS, OHIO STATE UNIVERSITY

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In a recent note[1] we have reported on the preliminary results on the measurement of the frequencies ν_2 and ν_4 in the infra-red spectra of GeH_4 and SiH_4 which lie in the region from 9.0μ to 14.0μ. The measurements have now been extended to embrace also the fundamental bands ν_3 in the spectra of these molecules. Inasmuch as considerable time will be required to study exhaustively the data gathered, it has seemed worth while to present a few facts concerning these spectra and a little of the information to be derived from them.

The band ν_3 in the SiH_4 spectrum is shown in figure 1. Curve 1-*A* was obtained using an absorption cell 6 cm. long containing gas to a pressure of 12 cm. Hg. The second curve, 1-*B*, was made using the same cell, but with a gas pressure of 6 cm. Hg. The former may be said to verify with high fidelity the measurements reported by Steward and Nielsen[2] on this spectrum when one considers that the improvement effected in the resolution since that time justifies the recording of data at intervals $^1/_6$ of those used by them. The second curve contains the same details, but the relative heights of the lines are markedly different. The conclusion to be drawn from the two curves is that in the former case too much gas was present so that the stronger lines are much "overexposed," with the weaker

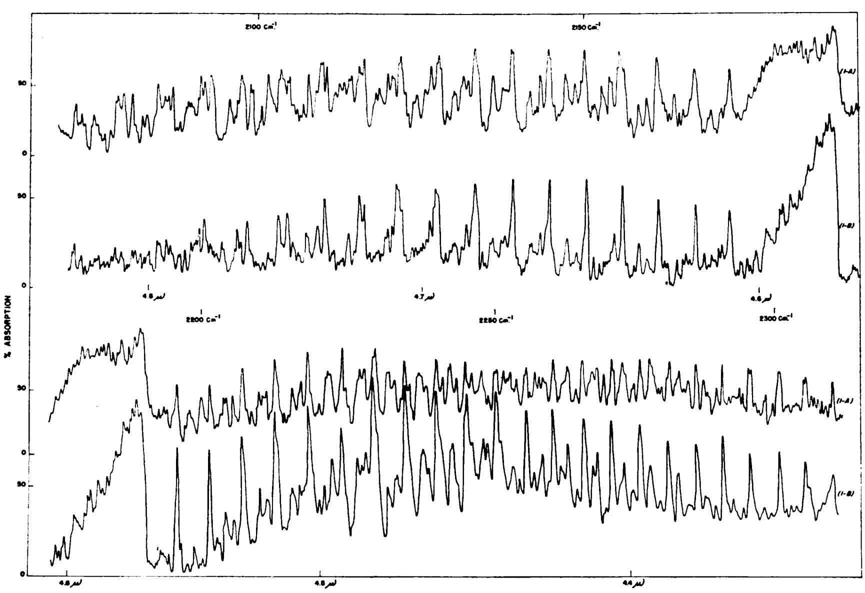

FIGURE 1

detail much overemphasized. We consider curve 1-*B* to be a much more accurate representation of the appearance of the band ν_3 in the spectrum of SiH_4 than curve 1-*A*.

These results lead directly to an interesting point concerning the band ν_3 in the spectrum of GeH_4. The original measurements reported by Steward and Nielsen[3] on this spectrum indicated that between the principal lines was to be found much weaker satellite lines. The presence of the satellite lines was verified by Lee and Sutherland,[4] but these investigators found them to be much more intense than was indicated in the work of Steward and Nielsen. We have investigated this point and we find that we can reproduce either the results of Steward and Nielsen or those obtained by Lee and Sutherland depending upon how much gas is present in the absorbing layer.

Using a cell 10 cm. long filled with gas to a pressure of 5 cm. Hg the curve of Steward and Nielsen can be quite faithfully duplicated when one considers the fact that the effective resolving power of the instrument has been greatly increased since the earlier measurements were made. The results of Lee and Sutherland are best duplicated (except that ours show considerably more detail) when the same cell is filled to a pressure of 10 cm. Hg, in which case the principal lines are much "overexposed." This curve is shown in figure 2-*A*. A much more reliable representation of the actual appearance of the band ν_3 in this spectrum, we believe, is depicted in figure 2-*B* which was obtained using the above cell with only about 1

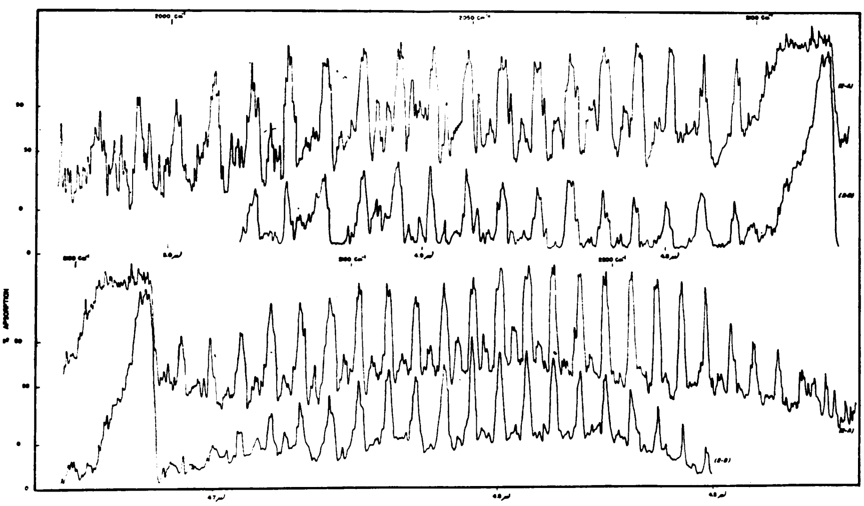

FIGURE 2

cm. Hg pressure. In this curve the satellites are quite faint and certainly cannot be regarded as of first order of magnitude. The only disturbing point is that the measurements of Lee and Sutherland and those by Steward and Nielsen were apparently carried out with the same equivalent absorbing layer and should therefore look alike. It should be pointed out that in the earlier experiment made by Steward and Nielsen there was evidence that some free hydrogen was present in the GeH_4 gas so that the pressure read on the manometer may have been due in part to the presence of this hydrogen. No attempt was made at that time to remove any hydrogen which was present since this gas would have no infra-red spectrum.

The three fundamentals ν_2, ν_3 and ν_4 studied in the spectra of these two molecules have been sufficiently well resolved so that the moments of inertia of the molecules may be determined. In the first six columns of table 1 the frequency positions of the bands ν_2, ν_3 and ν_4 and the average spacings between two rotation lines $\Delta\nu_i$ in the three bands are given for the two molecules.

A molecule of the tetrahedral XY_4 type is in zeroth approximation a spherical top with only a single principal moment of inertia so that one might expect all of the bands to have the same average spacing between two adjacent rotation lines. This is not the case, however, because the frequencies ν_3 and ν_4 which are threefold degenerate have an internal angular momentum of oscillation associated with them so that Coriolis interactions are set up between the rotational motion and the oscillatory motion of the molecule when it is vibrating in one of these modes. It has been pointed out by Teller[5] that the moment of inertia I cannot *in such cases* be determined from the usual formula $\Delta\nu = h/4\pi^2cI$, but rather by the relation $\Delta\nu_3 + \Delta\nu_4 = 3h/8\pi^2cI$. The values of the moments of inertia I for the two molecules determined in this manner are given in the seventh column of table 1.

The forbidden frequency ν_2, which is twofold degenerate, becomes optically active because of a resonance Coriolis interaction between it and the frequency ν_4. The amplitude of the internal angular momentum associated with ν_2 itself is zero so that the Coriolis interaction between the rotational motion and the oscillatory motion of the molecule vanishes when it oscillates in this mode. This gives an independent method of determining the moments of inertia since here the relation $\Delta\nu_2 = h/4\pi^2cI$ is again valid. The values of I obtained in this manner are given in the eighth column of table 1.

TABLE 1

INFORMATION CONCERNING THE SPECTRA AND STRUCTURE OF SiH_4 AND GeH_4

	ν_2 CM.$^{-1}$	$\Delta\nu_2$ CM.$^{-1}$	ν_3 CM.$^{-1}$	$\Delta\nu_3$ CM.$^{-1}$	ν_4 CM.$^{-1}$	$\Delta\nu_4$ CM.$^{-1}$	$I(\nu_3\nu_4)$ G.-CM.^{2}	$I(\nu_2)$ G.-CM.^{2}	X–H DISTANCE CM.
SiH_4	975	5.62	2191	5.64	910	2.77	0.998×10^{-39}	0.996×10^{-39}	1.50×10^{-8}
GeH_4	932	5.275	2114	5.67	818	2.27	1.057×10^{-39}	1.061×10^{-39}	1.54×10^{-8}

From the average values of I obtained in the above manner we have determined the Si–H distance and the Ge–H distance and these are set down in the ninth column of table 1.

In making these calculations we have neglected entirely the satellite structure in these bands. The explanation for this structure is not entirely clear. In the case of the bands ν_2 and ν_4, the curves of which are not shown here, much of the complex structure is certainly due to the Coriolis-resonance interaction which exists between the two vibrations. Some of the structure in ν_4 is undoubtedly due to the presence of the isotopic molecules. In the case of the band ν_3 in the spectrum of SiH_4 it seems possible to account for most of the satellites on the basis of three isotopes of Si. In the case of the band ν_3 in the spectrum of GeH_4 it does not seem possible to account for the secondary structure wholly on this basis. On the other hand, the secondary structure is in reality faint and can probably be attributed to several causes. For example, they may be a faint overtone band, say $3\nu_4$, lying in this region or they may be due to the splitting of the principal lines into components caused by centrifugal distortion of the molecule. Until a more intensive study of the data has been made on the basis of the theory of such molecules it seems necessary to postpone this question.

It is surprising to note that the two molecules have almost the same radius which is nearly $\sqrt{2}$ times that of the methane molecule. It is felt, however, that the data are so definite that little doubt can remain concerning the values $\Delta\nu_2$, $\Delta\nu_3$ and $\Delta\nu_4$ from which the moments of inertia and the X–H distances have been computed.

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MAXIMAL SUBGROUPS OF A FINITE GROUP

BY G. A. MILLER

DEPARTMENT OF MATHEMATICS, UNIVERSITY OF ILLINOIS

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It is possible to construct a cyclic group which contains exactly an arbitrary given number $k > 1$ of maximal proper subgroups. To do this it is only necessary to form the direct product of k cyclic groups of distinct prime power orders. Each of these k groups is known to contain one and only one maximal proper subgroup whenever the order of such a group is not a prime number. The ϕ-subgroup of such a group G is composed of all of its operators whose orders are not divisible by the highest power of at least one prime number which divides the order of the group. The ϕ-quotient group has for its order the product of all the distinct prime numbers which divide the order of G and the k maximal subgroups of G correspond to the subgroups of prime index in this quotient group. When $k = 1$ and the order of G is a prime number then G contains no maximal proper subgroup but when the order of G is a larger power of a prime